The Radio Observatory for Lunar Sortie Science and the Dark Ages Lunar Interferometer. J. Lazio[1], for the ROLSS and DALI teams, [1]Naval Research Laboratory, 4555 Overlook Ave. SW, Washington, DC 20375-5351; Lazio@nrl.navy.mil.

Introduction: Observations at radio wavelengths from the Moon address key problems in astrophysics, astrobiology, and lunar structure including

- *First light in the Universe* Prior to and during the formation of the first stars (i.e., the Dark Ages and the Epoch of Reionization), the intergalactic medium underwent significant temperature evolution and eventually became nearly totally ionized. The dominant baryonic component of the intergalactic medium is hydrogen, and its (redshifted) 21-cm hyperfine transition from these eras can be a precision probe of cosmology and tracer of the growth of large-scale structure.
- *Extrasolar Planets* Some solar system planets are significant radio emitters as a result of interactions between the solar wind and the planet's magnetospheric fields, and extrasolar planetary radio emission may be detectable over interstellar distances. For a terrestrial planet, a magnetic field may be important for habitability, shielding the planet from the harmful effects of energetic charged particles.
- *Particle Acceleration* A fundamental problem in astrophysics is understanding how particles are accelerated to super-thermal and relativistic energies. A radio wavelength array can probe particle acceleration in celestial objects, particularly by exploiting the nearby outer solar corona for high signal-to-noise observations but also in bright Galactic supernova remnants and luminous radio galaxies and quasars.
- *Lunar Ionosphere* The daylight side of the Moon has a photoelectron layer, probably coupled to the electrostatically-charged dust, but possibly extending to high altitudes as suggested by the Soviet Luna observations. A radio wavelength array can probe the lunar ionosphere by searching for absorption of broadband solar bursts longward of 150 meters (below 2 MHz).

Achieving the performance needed to address these scientific questions demands observations at wavelengths longer than those that penetrate the Earth's ionosphere, observations in extremely "radio quiet" locations such as the Moon's far side, or both.

We describe two concept studies in progress focussing on radio wavelength observatories on the Moon. The first is the Radio Observatory for Lunar Sortie Science (ROLSS), funded under the Lunar Sortie Science Opportunity (LSSO) program, and the second is the Dark Ages Lunar Interferometer (DALI), funded under the Astrophysics Strategic Mission Concept Studies (ASMCS) program.

ROLSS: The primary science mission of ROLSS is to probe particle acceleration in the inner heliosphere and to constrain the properties of the lunar ionosphere. ROLSS would be a radio interferometric array operating at wavelengths of 30–300 m (1–10 MHz) and would be the first imaging instrument at these wavelengths. The array is designed to be deployed during the first lunar sorties (or even before via robotic rovers), and would also serve as a pathfinder for a future larger telescope. Work in this concept study has focused on the science antenna, associated electronics, and a system-level analysis.

Science Antennas. While there is a considerable heritage of radio wavelength antennas at these wavelengths, deployment on the lunar surface presents several unique challenges. In addition to the lunar environment itself is the significant constraints on mass and volume, which have not traditionally been design constraints for radio astronomical antennas. The ROLSS science antenna concept (as well as for DALI) envisions dipole antennas deposited on polyimide film, which have the potential to be extremely low mass. Concept study work has focused on devloping an antenna topology that allows power to be transmitted to the electronics and whether polyimide film can survive exposure on the lunar surface. In addition, simple antenna deployers are under design.

Electronics. As for radio antennas, there is a considerable heritage of receivers (amplifiers, filters, and samplers) for radio astronomy as well as a heritage of space-based radio receivers. However, the ROLSS array envisions a much larger number of receivers than have been flown in previous remote sensing packages. Concept study work has focused on an integrated receiver design, with an aim toward identifying low-power components enabling large numbers of wide-bandwidth receivers.

System-level Design. Recently initiated has been a system-level review and trade study of the array design with the aim of developing an overall architecture and requirements (e.g,. power generation, lifetime, etc.).

Team. The ROLSS team consists of J. Lazio (NRL), J. Burns (U. Colorado), L. Demaio (NASA/GSFC), D. Jones (JPL), R. MacDowall (NASA/GSFC), K. Weiler (NRL), S. Bale (U. California, Berkeley), N. Gopalswamy (NASA/GSFC), M. Kaiser (NASA/GSFC), and J. Kasper (MIT).

DALI: The primary science mission for DALI is to probe the evolution of the intergalactic medium during the Universe's Dark Ages, and potentially into the Epoch of Reionization. DALI would be composed of a large number of antenna "stations" (each similar to the ROLSS array), deployed on the far side of the Moon. The redshift range that DALI could probe ranges from as low as 6 to as high as 100, with the actual set of redshifts (i.e., wavelengths or frequencies) to be informed in part by on-going ground-based work. The DALI concept study was initiated more recently than the ROLSS concept study, but many of the issues (low-mass antennas, low-power electronics, …) are similar and the DALI concept study will build upon the ROLSS study. In addition, it is envisioned that the DALI stations would be deployed by rovers, so concept study work also includes a component aimed at the design of low-mass, autonomous rovers for deployment.

Teams. The DALI team consists of J. Lazio (NRL), S. Neff (NASA/GSFC, GSFC Study Scientist), D. Jones (JPL, JPL Study Scientist), J. Burns (U. Colorado), S. Ellingson (Virginia Polytechnic), S. Furlanetto (UCLA), J. Kasper (CfA), R. MacDowall (NASA/GSFC), G. Taylor (New Mexico), H. Thronson (NASA/GSFC), K. Weiler (NRL), S. Bale (U. California, Berkeley), L. Demaio (NASA/GSFC), L. Greenhill (CfA), M. Kaiser (NASA/GSFC), J. Ulvestad (NRAO), and J. Weintroub (CfA),